

conditions. From the cool and humid winter to the hot and dry fore-summer the water content of normal species of *Opuntia* may change from about 80 to 65 per cent, and then rise again to 83 per cent during the humid but hot mid-summer. "Low water-content and high temperatures are associated with: (1) increase of polysaccharides; (2) decrease of monosaccharides; (3) increase of pentosans. High water-content and lower temperatures are associated with: (1) decrease of polysaccharides; (2) increase of monosaccharides; (3) decrease of pentosans." The author points out the significant fact that "the greatest activity of the plant comes at a time when the content of monosaccharides and disaccharides is highest," in March and April, although he is careful to state that a relatively large supply of simple sugars is not the only prerequisite for growth, but is only one of many factors.

In an arid atmosphere the cut joints undergo considerable decrease in water content, while still remaining normal in appearance and activity. The loss of water by transpiration and evaporation is partly compensated for by the water formed in the combustion of sugars, and partly by the condensation of the simple sugars into polysaccharides. Under drought the former decrease, while the latter and the pentosans increase, in total amount. The author suggests that the great imbibitional force of the pentosans may prevent the use of water for hydrolytic processes, when water becomes scarce in the tissue. These phenomena are closely correlated with temperature effects, when the latter are studied independently of varying moisture supply. Enzyme equilibria are discussed in connection with these two factors.

During the night the succulents respire sugar to acids, principally malic. This is not accompanied by an accumulation of alcohol. In an oxygen-free atmosphere, however, there is much less acid formed, and a very considerable amount of alcohol produced. One molecule of malic acid furnishes two of carbon dioxide and one of ethyl alcohol. Under these anaerobic conditions more sugar is consumed per unit of energy than under aerobic conditions. This is accompanied by an increase in the water content of the tissue.

During starvation the joints of *Opuntia* maintain the same relative proportions of the various carbohydrates. This disproves the theory that the pentoses are waste products of metabolism, since then they would show an increase. The water relations of the tissue during starvation and during periods of feeding on sugar solutions are discussed at some length.

SPOEHR advances the theory that the pentoses may be formed from glucuronic acid by the loss of a molecule of carbon dioxide, and discusses the isomerism relations between the hexoses and the corresponding pentoses that would be formed through the intermediary of glucuronic acid.—J. J. WILLAMAN.

**Transpiration in tropical rain forests.**—The lack of experimental data as to the conditions of plant growth and activity in tropical rain forests is apparently leading to some desirable investigation. A notable contribution in this

field is by McLEAN,<sup>9</sup> who worked in the rich forests on the slopes of the hills near Rio de Janeiro, Brazil. This is a region of high average humidity, due to a rainfall of 111.2 cm., the heaviest downfall being during the warmer months, and to a very considerable amount of cloudiness upon days with no rainfall. Considerable climatological data are presented, and a graph of climatic favorability is devised by combining the four factors of temperature, rainfall, relative humidity, and sunshine. The curve of this graph seems to show that the year may be divided into a more and a less favorable period, the latter extending from June to December.

Atmospheric humidity is shown to be high, even outside the forest cover. Graphs are presented showing the relative range of humidity and temperature at various levels of the vegetation. The latter records prove that a dense layer of shrubs divides the forest into two strata, the lower possessing cooler and more humid conditions than the lighter and better ventilated regions above. The author believes that this lower stratum is the less favorable to vegetation, and to it his experimental work is confined.

Transpiration measurements by means of potometers give the water loss by leaves in the lower stratum of the forest always less than 0.4 of the evaporation from a free water surface exposed alongside the foliage. Experiments within the laboratory with similar temperature and humidity, but with higher illumination, are shown to give similar results. Many of the shade leaves possess an amount of cutinization that reduces cuticular transpiration to a very slight amount. Structural studies show the intercellular spaces of sun and shade leaves to be relatively 16.3 and 24.8 per cent, and these amounts correspond very closely to those found in Europe. The size and amount of stomata seem to be rather decidedly smaller than that found in typical mesophytes of temperate lands. The vascular strands of the shade leaves are much smaller in cross-structure than those of sun leaves. These data, and the fact that the author believes the power of root absorption to be low, make it probable that, even in the protected region of the lower interior of the forest, transpiration may for short periods decidedly surpass the low capacity of the plants to supply water. This is supposed to account for cutinization, semi-succulence, and other xeromorphic tendencies and features of the tropical forests.

Under such conditions of reduced transpiration, however, there is no shortage of mineral matter, but on the contrary the leaves from shaded and protected habitats show relatively a richer content than do those sun forms with a much higher transpiration rate. This would prove that here at least the absorption of mineral salts is quite independent of any transpiration current.

A study of the foliage proves the predominance of the lanceolate leaf form and a remarkable prevalence of nyctitropic folding, which, however, does not

<sup>9</sup> McLEAN, R. C., *Studies in the ecology of tropical rain forests; with special reference to Brazil. I. Humidity.* Jour. Ecol. 7:5-54. pl. 1. figs. 21. 1919.

seem to have a marked effect upon water loss. With the latter phenomenon is associated an abundance of pulvini.

The report is to be commended as an attempt to apply quantitative methods in an almost untouched field.—GEO. D. FULLER.

**Heated soils.**—JOHNSON<sup>10</sup> has done a very critical and exhaustive piece of work on the effect of heating soils at various temperatures on the germination of seeds and later growth of plants in such soils. The heating at 114–116° C. was done in an autoclave; at higher temperatures the heating was done with air-dry soils in dry ovens. The duration of heating was about 2 hours.

Soils heated at 100–115° C. gave temporary retardation of germination and seedling growth, followed later by a great increase in rate of growth. The extent of these varied greatly with the soil, seed, and plants used, and with other environmental conditions. The injury increased as the temperature rose up to 250° C. As the temperature rose above 250° C. the injury decreased until it was nil with heating at 350° C. or above. The time of recovery from the toxic effects was proportional to the intensity of the toxicity. Soils showed considerable variation in the degree of effect of heating. This variation cannot be explained on the basis of any one characteristic of the soil, but seems to result from a combination of a number of its characters.

Seeds varied in their sensitiveness. Lettuce and clover are very sensitive, and wheat, buckwheat, and flax are resistant. Gramineae and Cucurbitaceae are usually resistant, while Leguminosae and Solanaceae are more sensitive. There is great variation in the response of the growing plants. Heated soils that proved very injurious to some plants, as tomatoes, may be beneficial to others, as wheat. In general, but not always, there is a parallel between the sensitiveness of germination and of the later growth of the seedling. *Pyronema*, some other fungi, and some bacteria grow best in soils heated to 250° C., and fall off in growth rate with soils heated to higher or lower temperatures.

The ammonia content of soils is highest in those heated at 250° C., and diminishes as the temperature of heating rises or falls. The same is true of the concentration of the soil solution, so that there is a rough parallel between these characters of the soil and the degree of toxicity or later increased growth. Adsorptive capacity of the soil modifies the action of the toxic substance. In soil extracts the toxicity is more nearly correlated with the concentration of the ammonia. Additions of ammonia to soil produce effects similar to heating. The author believes the toxic action of heated soils is largely due to ammonia existing as ammonium carbonate. He thinks other factors are involved in so-called "chemical" injuries.

The toxic material in heated soils is volatile. It is also changed into non-toxic form when the soil is kept under conditions favoring growth of organisms. The latter is due to soil flora, and, contrary to PICKERING, does

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<sup>10</sup> JOHNSON J., The influence of heated soils on seed germination and plant growth. *Soil Science* 7:1–87. 1919.